Online Appendix

Employer Consolidation and Wages: Evidence from Hospitals

Elena Prager and Matt Schmitt

Appendix A: Data Appendix

A1. Wages

This section provides additional detail regarding the construction of the wage measures used in the paper. Our data source for hospital wages is the Center for Medicare & Medicaid Services' (CMS) Healthcare Cost Report Information System (HCRIS). The HCRIS data include extensive information about hospital operations and finances. Wage information is contained in Worksheet S-3, Part II. We begin by restricting the data to general acute care hospitals—excluding specialty hospitals, such as dedicated pediatric hospitals and cancer centers—that are never designated as critical access hospitals. We do not have merger data for non-general acute care hospitals, and wage data are not available for critical access hospitals. HCRIS reports total wages and hours worked for several dozen separate line items, each of which is a fairly narrowly defined class of workers. We aggregate these line items into three broad categories of workers based on wage levels and the likely specificity of skills to the hospital industry.

We define the wage for *unskilled workers* as the (weighted) average across the Maintenance & Repairs, Operation of Plant, Laundry & Linen Service, Housekeeping, Dietary, Cafeteria, Central Services & Supply, and Medical Records & Medical Records Library line items. The unskilled worker category consists primarily of blue-collar workers. The largest line item in the category is Housekeeping, which in 2012 accounted for 31.6 percent of hours and 25.1 percent of wages in the category. We define the wage for *skilled workers* as the (weighted) average across the Employee Benefits Department, Administrative & General, Maintenance of Personnel, and Social Service line items. The skilled worker category consists primarily of white-collar workers. The largest line item in the category is Administrative & General, which in 2012 accounted for more than 85 percent of both hours and wages in the category. We define the wage for *nursing and pharmacy workers* as the (weighted) average across the Nursing Administration and Pharmacy line items. In 2012, approximately half of hours and wages in the category were accounted for by the Nursing Administration line item and the other half were accounted for by the Pharmacy line item.

In 2012, unskilled workers accounted for 13.3 percent of total hours and 7.7 percent of total wages in the HCRIS data. Skilled workers accounted for 12.6 percent of total hours and 13.8 percent of total wages. Nursing and pharmacy workers accounted for 3.8 percent of total hours and 4.7 percent of total wages. Only about half of the total reported hours and wages are broken out into distinct line items, which makes an exhaustive analysis of all hospital employees infeasible.

Despite this limitation of the data, the worker categories we examine (i) account for a substantial fraction of hospital hours and wages (29.7 percent of hours and 26.3 percent of wages in 2012), (ii) span a range of skill levels, and (iii) provide variation in the ease with which workers can likely substitute to non-hospital employment.

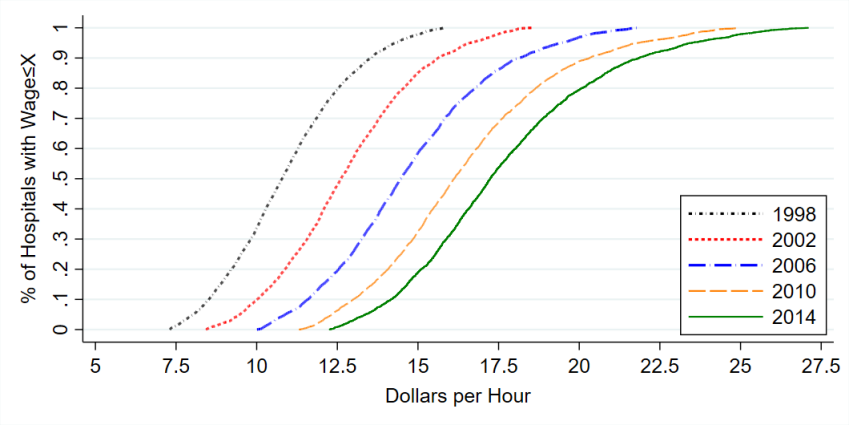
To provide quantitative support that the worker categories differ in terms of education levels, specificity of skills to the hospital industry, and worker mobility, we calculated a variety of statistics using the Current Population Survey (CPS).[32] Although occupation codes in the CPS do not match the HCRIS line items perfectly, a rough match is sufficient to make the main points. Using CPS data, we estimate that 66.0 percent of workers who would fall in our unskilled category have at most a high school diploma and only 9.0 percent hold at least a four-year college degree. In contrast, 35.4 percent of workers who would fall in our skilled category hold at least a four-year college degree, and 41.1 percent of workers who would fall in our nursing and pharmacy category hold at least a four-year college degree. Only 2.9 percent of unskilled workers are employed in the hospital industry, compared to 5.7 percent for skilled workers and 40.3 percent for nursing and pharmacy workers. Within the skilled category, the hospital industry accounts for a larger share of certain occupation codes. For example, 17.1 percent of billing and posting clerks are employed in the hospital industry. Finally, the nursing and pharmacy category also exhibits the greatest within-occupation persistence, with 61.3 percent of workers still employed in the same occupation code a year later, compared to 39.4 percent for the unskilled category.

The wage categories are also cleanly separated in terms of the wage levels observed in the HCRIS data. The line items included in the nursing and pharmacy category have uniformly higher median wages than the line items included in the skilled category, which have uniformly higher median wages than the line items included in the unskilled category. Figure A.1 plots the cumulative distribution function of each wage variable between 1998 and 2014 in four-year intervals. The skilled and nursing and pharmacy wage categories exhibit somewhat faster wage growth than the unskilled category over this period. The distributions also exhibit increased wage variation within category over time. The interquartile range for unskilled wages increased from \$2.64 in 1996 to \$3.88 in 2014. For skilled wages, the interquartile range increased from \$4.67 to \$10.97, and for nursing and pharmacy wages it increased from \$4.45 to \$8.41. In percentage terms, however, these differences are less apparent. In 1996, an unskilled worker at the 75th percentile of the wage distribution made 30 percent more than a worker at the 25th percentile. In 2014, the equivalent wage difference was 25 percent.

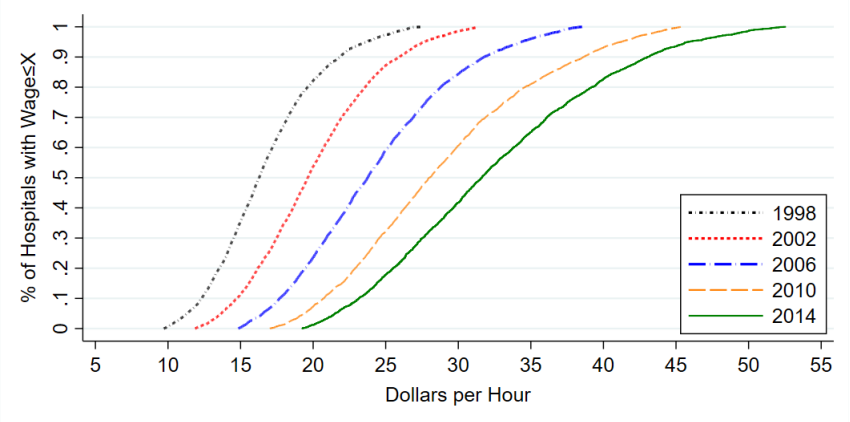
[32] We use the CPS extract processed and housed by IPUMS (Flood et al., 2018).

Figure A.1. : Wage CDFs

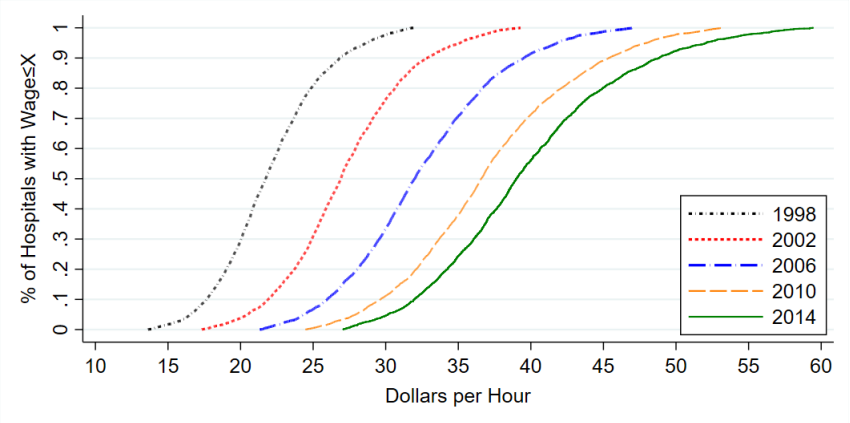
(a) Unskilled Wage



(b) Skilled Wage



(c) Nursing and Pharmacy Wage



A2. Employer Concentration

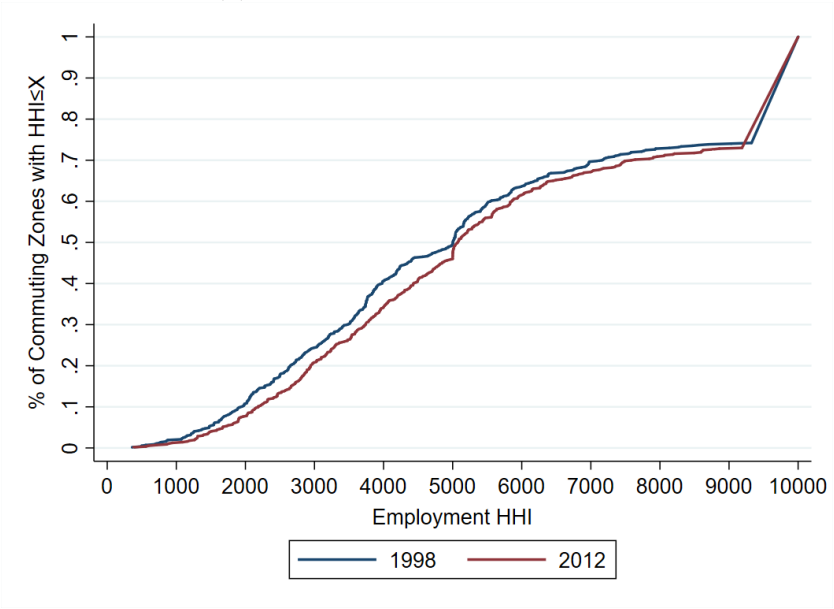
Figure A.2 provides additional summary statistics about hospital employer concentration in our data. The top panel of the figure presents the cumulative distribution function of hospital employer HHI across commuting zones in 1998 and 2012. The industry exhibits increasing concentration over time. In 1998, 17.5 percent of commuting zones had an HHI less than 2,500, compared to 13.3 percent in 2012. In 1998, 49.5 percent of commuting zones had an HHI less than 5,000, compared to 45.6 percent in 2012. The bottom panel of the figure plots the distribution of HHI across commuting zones in 2012. In general, rural areas tend to be much more concentrated than urban areas: in 2012, the correlation between commuting zone population and HHI was -0.45.

Figure A.3 plots the cumulative distribution functions of hospital employer HHI for the 84 treated commuting zones in our main difference-in-differences analysis. Each panel shows the pre- and post-merger HHI distributions for markets in a single quartile of ΔHHI. The supports of the pre-merger HHI distributions overlap across all four quartiles of ΔHHI. On average, however, markets with larger merger-induced changes in HHI are also more concentrated prior to the merger. Nearly a third of mergers in the top quartile of ΔHHI are mergers to monopsony (as measured by hospital employer HHI).

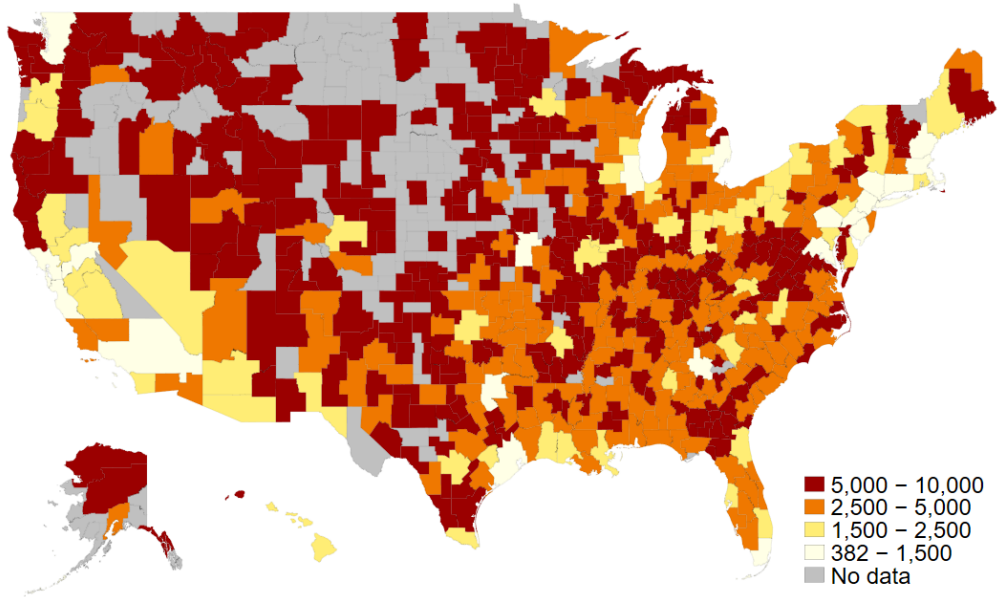
Hospital employment concentration and hospital product market concentration are positively correlated. Figure A.4 plots the pre-merger product market HHI and the change in product market HHI for the merger events in our data, defining geographic markets using commuting zones and using inpatient discharges to calculate shares. Mergers in the top quartile of employment ΔHHI (red diamonds in the figure) occur in highly concentrated product markets, and all imply sufficiently large likely increases in product market concentration that the merger would be presumed to be likely to enhance market power under the *Horizontal Merger Guidelines*.

Figure A.2. : Hospital Employer Concentration

(a) CDF of HHI, 1998 and 2012



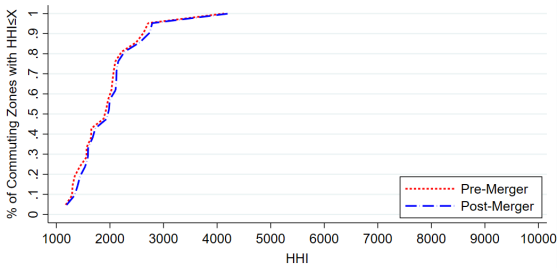
(b) HHI by commuting zone, 2012



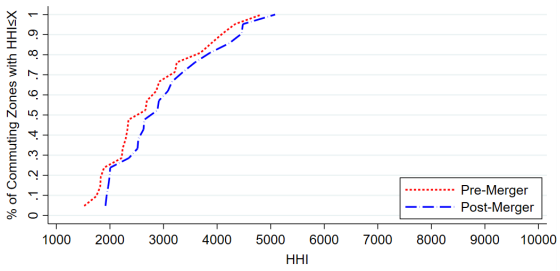
In the DOJ/FTC *Horizontal Merger Guidelines*, markets with an HHI below 1,500 are classified as unconcentrated; between 1,500 and 2,500, moderately concentrated; and above 2,500, highly concentrated.

Figure A.3. : Hospital Employer Concentration in Main Merger Sample

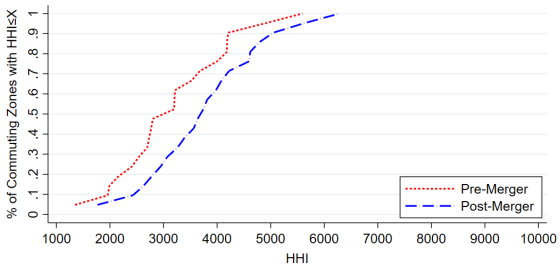
(a) 1st Quartile ΔHHI



(b) 2nd Quartile ΔHHI



(c) 3rd Quartile ΔHHI



(d) 4th Quartile ΔHHI

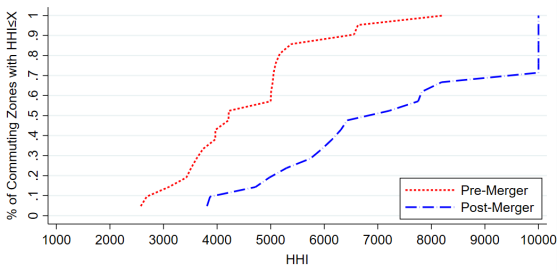
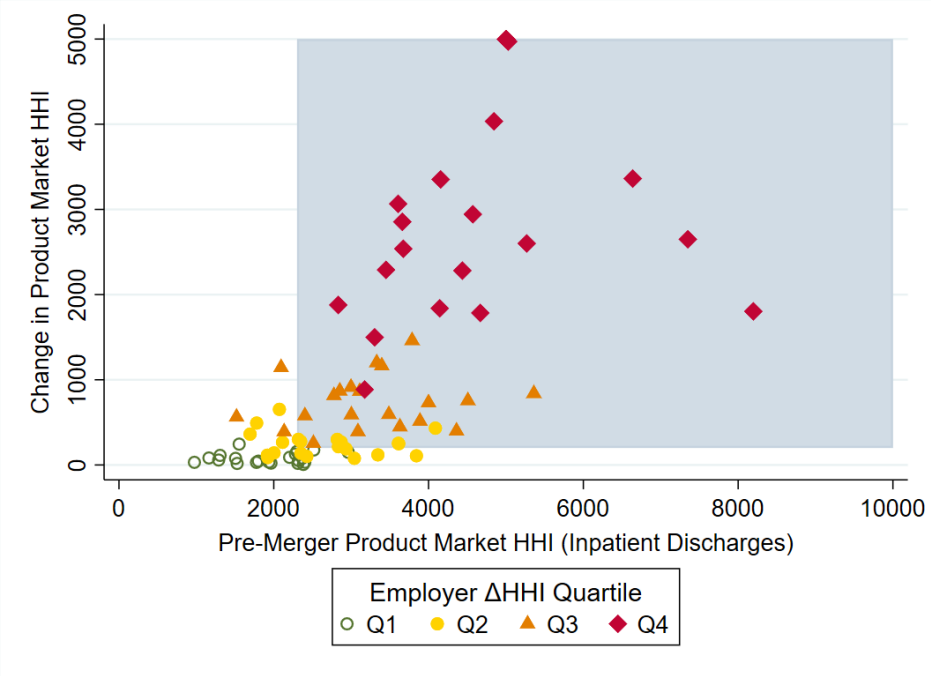


Figure A.4. : Product Market Concentration Changes by Merger Quartile



The change in product market concentration induced by the mergers in the baseline sample. Actual merger reviews use more sophisticated market definitions based on fact-finding through subpoenaed information. The gray shaded rectangle represents the region of pre-merger concentration (on the horizontal axis) and change in concentration (on the vertical axis) in which a merger is presumed to be likely to enhance market power.

Appendix B: Additional Results and Robustness Checks

B1. Aggregate Association Between Concentration and Wages

This section confirms that the hospital industry exhibits the same negative association between employer concentration and wages that has been documented in the recent literature. We regress wages on employer HHI for each of the three categories of workers defined in Section II.A:

$$\ln\left(wage_{imt}\right) = \delta_m + \tau_t + \alpha \cdot HHI_{m,t-1} + \boldsymbol{\beta} \cdot \mathbf{X}_{imt} + \epsilon_{imt}$$

where $wage_{imt}$ is the logarithm of wages for a given worker category in hospital i in year t; $HHI_{m,t-1}$ is our measure of hospital employer concentration, lagged by one year; and $\mathbf{X}_{imt}$ is the set of hospital and market characteristics included in our main difference-in-differences regressions (equation 1).

Table B.1 reports the results of these regressions, which cover the period of our ownership data (1998 to 2012). The point estimates are negative for all three worker categories, although the negative relationship is statistically significant only for the skilled worker category. To interpret the estimates, we focus on the implied wage difference between markets with an HHI of 2,500 (close to the median pre-merger HHI in our main treatment sample) and markets with an HHI of 5,000 (reflective of the mean merger-induced increase in HHI of 2,764 among the largest mergers in our difference-in-differences regressions; see Table 1). To put this comparison into context, note that a market with four equally sized firms has an HHI of 2,500 whereas a market with two equally sized firms has an HHI of 5,000. Taking the point estimates at face value, wages in a market with an HHI of 5,000 are 1.2 percent lower for unskilled workers than in an otherwise observably similar market with an HHI of 2,500, 4.1 percent lower for skilled workers, and 1.5 percent lower for nursing and pharmacy workers.[33] Although these estimates are consistent with the recent literature documenting a negative association between employer concentration and wages (Azar, Marinescu and Steinbaum, 2017; Rinz, 2018; Benmelech, Bergman and Kim, 2019; Hershbein, Macaluso and Yeh, 2019; Qiu and Sojourner, 2019), directly comparing quantitative magnitudes is complicated by the studies' differences in market definition, wage measures, and estimates of employer concentration. Nonetheless, the association between concentration and wages in our data appears to lie within the range of estimates in the existing literature. For example, Table B.1 suggests that a 1,000-point increase in HHI is associated with wages that are 1.7 percent lower for skilled workers. Expressing estimates in the literature in terms of 1,000-point HHI changes, estimates of the effect on wages range from 0.5 percent (Benmelech, Bergman and Kim, 2019) and 2.8 percent (Azar, Marinescu and Steinbaum, 2017) at the lower

[33] Omitting the additional controls can meaningfully affect the estimates. For instance, if we omit all of the additional controls—retaining only the commuting zone and year fixed effects—the point estimates for unskilled, skilled, and nursing and pharmacy wages are −0.059, −0.180, and −0.079, respectively, with all of the estimates statistically significant at the 10 percent level or better.

end to 29.5 percent at the upper end (Qiu and Sojourner, 2019).

Table B.1—: The Association Between HHI and Wages

	(1)	(2)	(3)
	Unskilled	Skilled	Nursing & Pharmacy
HHI_{t-1}	-0.049	-0.167***	-0.059
	(0.035)	(0.046)	(0.038)
Observations	41,893	42,555	42,502
R-squared	0.784	0.699	0.746
Estimated wage difference between HHI= 2,500 and HHI= 5,000:			
	-1.2%	-4.1%	-1.5%

Notes: ***p<0.01, **p<0.05, *p<0.10. All specifications include commuting zone and year fixed effects, plus the controls (log) one-bedroom rent, (log) population, (log) beds, (log) case mix index, % Medicare, % Medicaid, % outpatient charges, (log) per capita income, % unemployment, and % of the population age 65 or older. Standard errors are clustered by hospital and observations are weighted by total inpatient discharges. For readability, the coefficient estimates are scaled so that they reflect the effect of HHI when HHI is measured on a scale between zero and one.

B2. Reweighted Difference-in-Differences Estimates

Equation (1) is a difference-in-differences model with unit and time fixed effects. A recent literature in econometrics has shown that difference-in-differences models of this form yield a weighted average of all possible permutations of pairwise difference-in-differences estimators, where a pair is either the never-treated control group paired with a cohort of observations treated at time t, or a cohort of observations treated at time t paired with a cohort of observations treated at time $t' > t$.[34] Although the applied literature has not yet reached a consensus on how to deal with this issue, we take two approaches consistent with what has been proposed in the nascent literature.

First, we estimate event study-style specifications with saturated leads and lags, in which case the estimates are influenced only by comparisons between the never-treated control group and treated observations (Section III.D). Second, we combine the insights of Goodman-Bacon (2018) and Callaway and Sant'Anna (2019) to produce an estimate of the sample volume-weighted average of cohort-wise difference-in-differences estimators across each cohort of merger treatments in our sample. To construct this estimate, we first estimate a separate regression for each treated cohort that uses only observations from markets whose treatment begins at time t and never-treated observations (following Goodman-Bacon (2018)). Next, we take a weighted average of the cohort-specific point estimates with weights equal to each cohort's share of all treated observations (in the spirit of Callaway and Sant'Anna (2019)). Table B.2 reports these decomposed-and-reweighted estimates, which are nearly indistinguishable from our baseline results.

[34] This characterization was proposed by Goodman-Bacon (2018). For other related approaches, see Callaway and Sant'Anna (2019) and de Chaisemartin and D'Haultfoeuille (2019).

Table B.2—: Cohort-by-Cohort Estimation

	(1)	(2)
	Main Text	Wgt. Avg. of Cohort-by-Cohort
Unskilled:		
Post × 1st quartile ΔHHI	0.004	0.004
Post × 2nd quartile ΔHHI	0.007	0.007
Post × 3rd quartile ΔHHI	0.007	0.007
Post × 4th quartile ΔHHI	0.002	0.001
Skilled:		
Post × 1st quartile ΔHHI	0.005	0.002
Post × 2nd quartile ΔHHI	-0.022	-0.022
Post × 3rd quartile ΔHHI	0.002	0.003
Post × 4th quartile ΔHHI	-0.041	-0.040
Nursing & Pharmacy:		
Post × 1st quartile ΔHHI	0.002	0.002
Post × 2nd quartile ΔHHI	-0.001	-0.001
Post × 3rd quartile ΔHHI	-0.019	-0.018
Post × 4th quartile ΔHHI	-0.070	-0.067

Notes: Column (1) repeats the point estimates for the coefficients of interest from the baseline regressions in the main text (equation (1) / Table 3). Column (2) reports the results obtained by estimating the difference-in-differences model treated cohort by treated cohort and reweighting the cohort-specific estimated treatment effects by cohort size (in the style of Goodman-Bacon (2019) and Callaway and Sant'Anna (2019)).

B3. Local Economic Conditions

Table 4 in the main text tests for differentially worsening economic conditions in the treatment markets. For brevity, the table in the main text reported only the coefficients for the top quartile of ΔHHI. Table B.3 reports an expanded version with all four quartiles of ΔHHI. In Panel A, although we detect some differences between treatment and control markets in terms of economic variables like per capita income, the results do not follow any clear pattern that would cause us to question the validity of our main estimates. In Panel B, where we estimate specifications with adjustments for the Great Recession, we continue to estimate small and statistically insignificant effects for all three categories of workers following mergers in the first three quartiles of ΔHHI.

Chinese import competition has been shown to be an important driver of local economic conditions (Autor, Dorn and Hanson, 2013). If hospital mergers are correlated with the time-varying impacts of Chinese import competition, then we may mistakenly attribute the effects of import competition to the mergers. To address this possibility, we reconstruct a panel data version of Autor, Dorn and Hanson's measure from trade flows data (Comtrade, 2019) and add it to our regressions.[35] Table B.4 reports the results, which are very similar to our baseline estimates. Making either one of these modifications separately (controlling for Chinese import competition or the Great Recession) also yields very similar estimates. In sum, we do not detect evidence that the wage effects we observe following mergers in the top quartile of ΔHHI can be explained by broader local economic conditions, including the effects of the Great Recession as well as Chinese import competition.

[35] We use trade flow data from CEPII (2019), industry activity data from Bureau (2019), extended commuting zone definitions from Fowler, Rhubart and Jensen (2016).

Table B.3—: Local Economic Conditions (All Four Quartiles of ΔHHI)

Panel A: Commuting Zone Economic Outcomes

	Unemployment	(log) Population	(log) Per Capita Income
Post × 1st quartile ΔHHI	-0.002	0.021**	-0.006
	(0.003)	(0.010)	(0.010)
Post × 2nd quartile ΔHHI	0.005**	0.017*	-0.030***
	(0.002)	(0.010)	(0.009)
Post × 3rd quartile ΔHHI	0.002	0.015	-0.020*
	(0.002)	(0.014)	(0.011)
Post × 4th quartile ΔHHI	-0.000	-0.004	0.029
	(0.003)	(0.014)	(0.019)

Panel B: Great Recession Specifications

	Drop 2008-2009	Drop CZs Treated in 2008-2009	Add Further Recession Controls
Unskilled:			
Post × 1st quartile ΔHHI	0.002	0.004	0.001
	(0.006)	(0.007)	(0.006)
Post × 2nd quartile ΔHHI	0.008	0.001	0.007
	(0.009)	(0.009)	(0.009)
Post × 3rd quartile ΔHHI	0.007	0.015	0.007
	(0.009)	(0.009)	(0.008)
Post × 4th quartile ΔHHI	-0.003	0.001	0.001
	(0.015)	(0.015)	(0.015)
Skilled:			
Post × 1st quartile ΔHHI	0.008	-0.003	0.003
	(0.011)	(0.011)	(0.011)
Post × 2nd quartile ΔHHI	-0.023	-0.017	-0.023
	(0.018)	(0.019)	(0.015)
Post × 3rd quartile ΔHHI	0.012	0.007	0.001
	(0.024)	(0.021)	(0.021)
Post × 4th quartile ΔHHI	-0.042**	-0.036*	-0.038*
	(0.019)	(0.020)	(0.020)
Nursing & Pharmacy:			
Post × 1st quartile ΔHHI	-0.002	-0.003	0.002
	(0.010)	(0.010)	(0.009)
Post × 2nd quartile ΔHHI	0.003	-0.010	-0.001
	(0.010)	(0.010)	(0.010)
Post × 3rd quartile ΔHHI	-0.016	-0.018	-0.019
	(0.015)	(0.015)	(0.014)
Post × 4th quartile ΔHHI	-0.063***	-0.077***	-0.072***
	(0.019)	(0.022)	(0.023)

Notes: ***p<0.01, **p<0.05, *p<0.10. See the notes to Table 4 for more details.

Table B.4—: Controlling for the Great Recession and the China Shock

	(1)	(2)	(3)
	Unskilled	Skilled	Nursing & Pharmacy
Post × 1st quartile ΔHHI	0.001	0.003	0.002
	(0.006)	(0.011)	(0.009)
Post × 2nd quartile ΔHHI	0.007	-0.023	-0.002
	(0.009)	(0.015)	(0.010)
Post × 3rd quartile ΔHHI	0.007	0.000	-0.020
	(0.008)	(0.021)	(0.014)
Post × 4th quartile ΔHHI	0.000	-0.039*	-0.073***
	(0.015)	(0.020)	(0.023)
ln(China Shock)	-0.005	-0.004	-0.005
	(0.004)	(0.010)	(0.006)
Observations	17,412	17,397	17,272
R-squared	0.913	0.853	0.875
H_0: no heterogeneity	0.894	0.172	0.012**

Notes: ***p<0.01, **p<0.05, *p<0.10. All specifications include hospital and year fixed effects, plus the controls (log) one-bedroom rent, (log) population, (log) beds, (log) case mix index, % Medicare, % Medicaid, % outpatient charges, (log) per capita income, % unemployment, % of the population age 65 or older, and a control for the effect of the Great Recession on housing prices (from Mian and Sufi (2014)) interacted with the year fixed effects. Standard errors are clustered by hospital and observations are weighted by total inpatient discharges. The bottom row reports the p-value of a test of the null hypothesis that the post×ΔHHI quartile effects are equal to one another.

B4. Alternative Control Groups

This section provides further discussion of observable differences between hospitals in the treatment and control groups, along with regression results from specifications that modify the control group. Table B.5 reports summary statistics for the treatment and control groups prior to the mergers under examination. As explained in the main text, our preferred specification defines the control group as hospitals in commuting zones that do not experience any mergers over the course of our sample period (column "No Acq." in Table B.5). Hospitals in this control group are on average smaller than hospitals in the treatment group, and exhibit a different geographic distribution across the US.

We also repeat our main regressions with two alternate definitions of the control group. First, we expand the control group to also include commuting zones that experienced only out-of-market mergers (column "Expanded" in Table B.5). This addition nearly doubles the size of the control group. Second, we use the expanded control group to construct a set of more restrictive matched controls based on the observables in Table B.5: hospital-specific characteristics like wage levels and discharge volume, market-specific characteristics like population, and Census division. Specifically, we use 1-to-1 optimal matching using Mahalanobis distance as the distance metric (Stuart, 2010). The matched controls regressions compare wage changes among hospitals affected by a concentration-increasing merger event to wage changes among observably similar hospitals that are unaffected by mergers. This approach mitigates any differences in wage trends that are attributable to selection on observables into merger events.

Regression results are reported in Table B.6. Columns (1) to (3) copy the results from Table 3 in the main text. Columns (4) to (6) report the results from expanding the control group to include commuting zones only experiencing out-of-market mergers. Columns (7) to (9) report the results for the matched control group—the matched controls specification also allows all of the model parameters to vary freely across quartile of ΔHHI (with each control hospital assigned to the quartile of its matched treatment hospital).[36] Both the qualitative patterns and the magnitude and significance of the coefficients are very similar across the control groups. We estimate statistically significant negative wage effects only following mergers in the top quartile of ΔHHI, and only for the skilled and nursing and pharmacy worker categories.

[36]That is, the reported matched controls estimates are equivalent to estimating separate regressions for the hospitals in each quartile of ΔHHI along with their corresponding matched controls.

Table B.5—: Treatment and Control Hospital Observable Characteristics

		Control Group			Standardized Difference		
	Treated	No Acq.	Expanded	Matched	No Acq.	Expanded	Matched
Hospitals	569	819	1,576	569	–	–	–
Unskilled wage	$10.94	$10.56	$10.67	$10.44	0.175	0.127	0.232
Skilled wage	$16.60	$15.95	$16.23	$15.57	0.151	0.087	0.239
Nursing & pharmacy wage	$21.72	$21.74	$22.11	$21.24	0.004	0.084	0.105
Total FTEs	1,129	749	735	897	0.400	0.414	0.244
Inpatient discharges	9,452	5,701	5,878	7,351	0.519	0.495	0.291
Beds	219	141	146	174	0.528	0.497	0.300
Case mix index	1.383	1.293	1.301	1.336	0.371	0.338	0.193
% Medicare	0.400	0.454	0.452	0.434	0.357	0.349	0.229
% Medicaid	0.124	0.148	0.149	0.142	0.250	0.260	0.186
% Outpatient charges	0.400	0.454	0.439	0.424	0.397	0.289	0.172
One-bedroom rent	$444	$384	$392	$398	0.588	0.505	0.444
CZ population (millions)	1.068	0.343	0.486	0.572	1.082	0.870	0.741
CZ per capita income	$25,859	$22,830	$23,346	$23,348	0.602	0.499	0.499
CZ % unemployment	0.044	0.053	0.054	0.050	0.342	0.403	0.254
CZ % age 65 or older	0.134	0.136	0.135	0.134	0.080	0.037	0.011
Nurse unionization rate	0.159	0.121	0.113	0.137	0.292	0.360	0.170
Census division:							
East North Central	0.130	0.184	0.146	0.130	0.150	0.046	0.000
East South Central	0.100	0.087	0.129	0.100	0.046	0.090	0.000
Middle Atlantic	0.123	0.055	0.053	0.123	0.241	0.248	0.000
Mountain	0.056	0.118	0.092	0.056	0.222	0.137	0.000
New England	0.044	0.044	0.025	0.044	0.000	0.106	0.000
Pacific	0.120	0.068	0.082	0.120	0.176	0.123	0.000
South Atlantic	0.214	0.200	0.186	0.214	0.035	0.071	0.000
West North Central	0.088	0.149	0.139	0.088	0.190	0.162	0.000
West South Central	0.125	0.094	0.148	0.125	0.099	0.067	0.000

Notes: Values are for 1998 if available and the first year that a hospital appears in the data otherwise.

Table B.6—: Alternative Control Groups

Panel A: No Acquisition Activity (main text)

	(1)	(2)	(3)
	Unskilled	Skilled	Nursing & Pharmacy
Post × 1st quartile ΔHHI	0.004	0.005	0.002
	(0.006)	(0.010)	(0.009)
Post × 2nd quartile ΔHHI	0.007	-0.022	-0.001
	(0.009)	(0.016)	(0.010)
Post × 3rd quartile ΔHHI	0.007	0.002	-0.019
	(0.008)	(0.021)	(0.014)
Post × 4th quartile ΔHHI	0.002	-0.041**	-0.070***
	(0.014)	(0.019)	(0.022)
H_0: no heterogeneity	0.978	0.105	0.016**

Panel B: Expanded (include CZs with only out-of-market mergers)

	(4)	(5)	(6)
	Unskilled	Skilled	Nursing & Pharmacy
Post × 1st quartile ΔHHI	0.001	0.000	0.001
	(0.006)	(0.010)	(0.009)
Post × 2nd quartile ΔHHI	0.002	-0.025	-0.006
	(0.009)	(0.016)	(0.010)
Post × 3rd quartile ΔHHI	0.005	-0.000	-0.016
	(0.008)	(0.021)	(0.013)
Post × 4th quartile ΔHHI	-0.004	-0.043**	-0.071***
	(0.014)	(0.018)	(0.024)
H_0: no heterogeneity	0.942	0.133	0.033**

Panel C: Matched (match treated hospitals to controls on observables)

	(7)	(8)	(9)
	Unskilled	Skilled	Nursing & Pharmacy
Post × 1st quartile ΔHHI	0.004	-0.005	-0.004
	(0.006)	(0.011)	(0.010)
Post × 2nd quartile ΔHHI	-0.005	-0.014	0.007
	(0.011)	(0.018)	(0.012)
Post × 3rd quartile ΔHHI	0.005	-0.012	-0.023*
	(0.009)	(0.023)	(0.013)
Post × 4th quartile ΔHHI	0.001	-0.062**	-0.059***
	(0.014)	(0.029)	(0.020)
H_0: no heterogeneity	0.893	0.327	0.024**

Notes: ***p<0.01, **p<0.05, *p<0.10. All specifications include hospital and year fixed effects, plus the controls (log) one-bedroom rent, (log) population, (log) beds, (log) case mix index, % Medicare, % Medicaid, % outpatient charges, (log) per capita income, % unemployment, and % of the population age 65 or older. Standard errors are clustered by hospital and observations are weighted by total inpatient discharges. The bottom row reports the p-value of a test of the null hypothesis that the post×ΔHHI quartile effects are equal to one another. In Panel C, the regression is estimated for each quartile of ΔHHI separately using the corresponding matched controls.

B5. Alternative Wage Category Definitions

We have also estimated our main difference-in-differences regressions using an alternative definition of worker categories. With the alternative definition, we estimate the regressions using only the largest HCRIS line item within each category in order to minimize the contribution of labor composition changes to the estimates. The largest line item within the unskilled worker category is Housekeeping, which in 2012 accounted for 31.6 percent of hours and 25.1 percent of wages in the category. The largest line item in the skilled category is Administrative & General, which in 2012 accounted for more than 85 percent of both hours and wages in the category. For the nursing and pharmacy category, we report estimates for the Nursing Administration and Pharmacy line items separately. In the baseline definition of the nursing and pharmacy category, approximately half of hours and wages were accounted for by the Nursing Administration line item and the other half were accounted for by the Pharmacy line item.

The estimates are reported in Table B.7. As with the results reported in the main text, we detect evidence of reduced wage growth only for the skilled, nursing, and pharmacy categories and only for large changes in HHI. Negative wage effects are most apparent for the Nursing Administration line item, which is consistent with that set of workers having the skillset that is least mobile outside of the hospital industry.

Table B.7—: Alternative Wage Categories

	(1)	(2)	(3)	(4)
	House-keeping	Admin-istrative & General	Nursing Admin-istration	Pharmacy
Post	0.004	-0.004	-0.017**	0.003
	(0.005)	(0.009)	(0.009)	(0.006)
Observations	17,133	17,392	17,103	12,106
R-squared	0.898	0.830	0.798	0.933
	(5)	(6)	(7)	(8)
	House-keeping	Admin-istrative & General	Nursing Admin-istration	Pharmacy
Post × 1st quartile ΔHHI	0.003	0.010	-0.009	0.012
	(0.008)	(0.012)	(0.012)	(0.008)
Post × 2nd quartile ΔHHI	0.009	-0.022	-0.002	-0.006
	(0.008)	(0.017)	(0.013)	(0.010)
Post × 3rd quartile ΔHHI	-0.001	-0.001	-0.043***	0.006
	(0.009)	(0.021)	(0.016)	(0.014)
Post × 4th quartile ΔHHI	-0.001	-0.051**	-0.078*	-0.041***
	(0.010)	(0.022)	(0.041)	(0.014)
Observations	17,133	17,392	17,103	12,106
R-squared	0.898	0.830	0.798	0.933
H_0: no heterogeneity	0.837	0.066*	0.074*	0.007***

Notes: ***p<0.01, **p<0.05, *p<0.10. All specifications include hospital and year fixed effects, plus the controls (log) one-bedroom rent, (log) population, (log) beds, (log) case mix index, % Medicare, % Medicaid, % outpatient charges, (log) per capita income, % unemployment, and % of the population age 65 or older. Standard errors are clustered by hospital and observations are weighted by total inpatient discharges. The bottom row reports the p-value of a test of the null hypothesis that the post×ΔHHI quartile effects are equal to one another. The sample is restricted, respectively, to the largest line item within the unskilled worker category (Housekeeping), the largest line item in the skilled category (Administrative & General), and to the Nursing Administration and Pharmacy items separately.

B6. Alternative Geographic Market Definitions

Our main analyses use commuting zones to delineate the geographic borders of the labor market. Table B.8 presents our main results with two alternative geographic market definitions. The first alternative uses core-based statistical areas (CBSAs), which are contiguous groups of counties that also capture commuting patterns. CBSAs are more granular than commuting zones: although they are comparable to commuting zones in number (917 CBSAs, compared to 709 commuting zones), CBSAs exclude a larger fraction of the United States, so the average CBSA is smaller than the average commuting zone. The second alternative uses hospital referral regions (HRRs), which are contiguous groups of zip codes whose residents use the same sets of hospitals for complex care. There are 306 HRRs, which are typically broader than commuting zones. Using CBSAs to define geographic markets reduces the number of treatment hospitals by about 30 percent (from 569 to 379), while using HRRs to define geographic markets increases the number of treatment hospitals by about 30 percent (from 569 to 728).

Using the narrower definition of geographic markets (CBSAs) yields results similar to our main estimates (Panel B of Table B.8). The coarser definition of geographic markets (HRRs) yields smaller (but still negative) point estimates in the top quartile of ΔHHI that are no longer statistically significant (Panel C of Table B.8). Attenuation along these lines is to be expected when the specified geographic market is expanded beyond the true relevant labor market. Thus, these results indicate that the relevant labor market in our context may generally be narrower than the HRR.

Table B.8—: Alternative Geographic Markets

Panel A: Commuting Zone (main text)

	(1)	(2)	(3)
	Unskilled	Skilled	Nursing & Pharmacy
Post × 1st quartile ΔHHI	0.004	0.005	0.002
	(0.006)	(0.010)	(0.009)
Post × 2nd quartile ΔHHI	0.007	-0.022	-0.001
	(0.009)	(0.016)	(0.010)
Post × 3rd quartile ΔHHI	0.007	0.002	-0.019
	(0.008)	(0.021)	(0.014)
Post × 4th quartile ΔHHI	0.002	-0.041**	-0.070***
	(0.014)	(0.019)	(0.022)
H_0: no heterogeneity	0.978	0.105	0.016**

Panel B: CBSA (smaller)

	(4)	(5)	(6)
	Unskilled	Skilled	Nursing & Pharmacy
Post × 1st quartile ΔHHI	0.001	0.006	0.005
	(0.006)	(0.012)	(0.010)
Post × 2nd quartile ΔHHI	-0.005	-0.020	0.004
	(0.012)	(0.014)	(0.011)
Post × 3rd quartile ΔHHI	0.016*	0.000	-0.009
	(0.009)	(0.027)	(0.017)
Post × 4th quartile ΔHHI	0.016	-0.037*	-0.085***
	(0.017)	(0.020)	(0.027)
H_0: no heterogeneity	0.362	0.207	0.014**

Panel C: HRR (larger)

	(7)	(8)	(9)
	Unskilled	Skilled	Nursing & Pharmacy
Post × 1st quartile ΔHHI	0.005	0.002	0.004
	(0.006)	(0.010)	(0.009)
Post × 2nd quartile ΔHHI	0.008	-0.019	0.004
	(0.008)	(0.014)	(0.009)
Post × 3rd quartile ΔHHI	0.007	0.004	-0.014
	(0.007)	(0.018)	(0.012)
Post × 4th quartile ΔHHI	0.003	-0.022	-0.026
	(0.012)	(0.017)	(0.019)
H_0: no heterogeneity	0.989	0.374	0.313

Notes: ***p<0.01, **p<0.05, *p<0.10. All specifications include hospital and year fixed effects, plus the controls (log) one-bedroom rent, (log) population, (log) beds, (log) case mix index, % Medicare, % Medicaid, % outpatient charges, (log) per capita income, % unemployment, and % of the population age 65 or older. Standard errors are clustered by hospital and observations are weighted by total inpatient discharges. The bottom row reports the p-value of a test of the null hypothesis that the post×ΔHHI quartile effects are equal to one another.

B7. Successive Mergers

In the main analysis, we restrict attention to markets that experience no more than one concentration-increasing merger event throughout the sample period. This sample restriction avoids contaminating the estimates with the effects of later mergers in the same market. However, it limits the generalizability of our findings to markets with multiple merger events. Table B.9 therefore reports estimates from regressions using markets with up to four merger events. We estimate a simple specification that models the effects of successive mergers within the same market additively. To do so, we replace the Post$\times\Delta$HHI indicators in our main specification with the *count* of mergers in each quartile of ΔHHI that occurred within the commuting zone by that year. In addition to the 84 commuting zones with a single merger event, these specifications include the 25 commuting zones with two merger events, the 12 commuting zones with three merger events, and the 6 commuting zones with four merger events. We drop the 7 commuting zones with five or more merger events because the additive structure is less plausible as the number of merger events increases, but the estimates are similar when including them.

The estimates are broadly similar to our main results: we continue to estimate negative and statistically significant wage effects for skilled and nursing and pharmacy workers following mergers in the top quartile of ΔHHI. The magnitude of the estimate for the skilled worker category falls, but the estimate remains statistically significant. In contrast to our main results, we also estimate statistically significant (but smaller) wage effects following mergers in other quartiles. However, given the difficulty of identification in this setting—e.g., if a merger in the top quartile of ΔHHI occurs in year t, a merger in the first quartile of ΔHHI occurs in year $t+1$, and wage growth slows in year $t+2$, it is difficult to isolate the cause—we think it unwise to put too much emphasis on this result. Overall, we interpret these results as being qualitatively consistent with our baseline results, while noting that the imposed additive structure does not capture more complex relationships between successive mergers in the same market.

Table B.9—: Including CZs With Multiple Mergers

Panel A: Single Concentration Increase (main text)

	(1)	(2)	(3)
	Unskilled	Skilled	Nursing & Pharmacy
Post × 1st quartile ΔHHI	0.004	0.005	0.002
	(0.006)	(0.010)	(0.009)
Post × 2nd quartile ΔHHI	0.007	-0.022	-0.001
	(0.009)	(0.016)	(0.010)
Post × 3rd quartile ΔHHI	0.007	0.002	-0.019
	(0.008)	(0.021)	(0.014)
Post × 4th quartile ΔHHI	0.002	-0.041**	-0.070***
	(0.014)	(0.019)	(0.022)
H_0: no heterogeneity	0.978	0.105	0.016**

Panel B: Additive Effects from Multiple Mergers

	(4)	(5)	(6)
	Unskilled	Skilled	Nursing & Pharmacy
Post × 1st quartile ΔHHI	0.000	-0.001	-0.006**
	(0.002)	(0.003)	(0.003)
Post × 2nd quartile ΔHHI	-0.006	-0.016***	-0.010*
	(0.004)	(0.006)	(0.005)
Post × 3rd quartile ΔHHI	0.001	0.001	-0.012
	(0.007)	(0.012)	(0.008)
Post × 4th quartile ΔHHI	0.005	-0.025*	-0.062***
	(0.018)	(0.015)	(0.024)
H_0: no heterogeneity	0.502	0.051*	0.070*

Notes: ***p<0.01, **p<0.05, *p<0.10. All specifications include hospital and year fixed effects, plus the controls (log) one-bedroom rent, (log) population, (log) beds, (log) case mix index, % Medicare, % Medicaid, % outpatient charges, (log) per capita income, % unemployment, and % of the population age 65 or older. Standard errors are clustered by hospital and observations are weighted by total inpatient discharges. The bottom row reports the p-value of a test of the null hypothesis that the post×ΔHHI quartile effects are equal to one another. Panel B includes commuting zones experiencing up to four merger events. This specification replaces the post×ΔHHI indicators with the count of mergers in each quartile of ΔHHI that occurred within the commuting zone by that year.